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Cheng Yong-jiang
Xi'an Jiaotung University

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Cheng Yong-jiang Department Power Machinery
Xi'an Jiaotung University, Xi'an, Shaanxi Pr.
China.

ABSTRACT

The sliding valve has appeared for a long time, but could not be available to industry popularly owing to the fact that its transmission is not reliable. Based on the mechanical transmission principle of the dieseloil pump, the author employs a crank to drive a cam shaft, which controls the intake and exhaust of gas pushing through a gear chain, thus controlling the sliding valve switch on and off. After hundred year's experience of the mechanical transmission of cam in a diesel, the time of switching on and off and the continuation of switching on position are reliable, if we select a certain cam profile.

INTRODUCTION

The Device and its Trasmission Method

Fig.1 is the cross section of the device. The internal diameter of the cylinder 8 D is 153 mm. The top of the piston 11 is the common valve seat 10 for the intake and exhaust valve. On the right of the figure under 10 is the intake sliding valve 9, and on the left above 10 is the exhaust valve 14. They are all connected with sliding valve lever, which is mounted on a guide-piston 4 like that of a Boche oil pump. The roller 3 on the pin of the guide-piston is in contact with the cam 2, and is pressed onto the cam by the spring of oil pump 5. The cam shaft keeps a certain angle with the crank of the compressor by a chain roller 1 and its chain, remaining the same speed with the crank.

Fig.1 shows that the piston is in an expansion process. The base circle of intake gas cam has turned around a whole circle. The cam, which is 5.25 mm higher than the base circle, will raise the roller 3, and the intake valve 9 will be shifted 5.25 mm to the left. Therefore it will connect the seven parallel straight slots on the sliding valve 9 with the same slots on the common valve seat 10, and the gas passes into the cylinder directly. After the cam turns around a certain intake angle, the piston is close to the B.D.C. The roller comes into contact with the base circle from the profile of the cam by the spring force. The intake valve returns to the original switching off position.

The lever of intake and exhaust valve is sealed with stuffing box 7 and 15. For adaptation to the position of intake valve, the top of the piston consists of a pair of ladderlike semicircles. 13 is the guide block of the exhaust valve.

The straight slot of the device is 4 mm in width, its both sides have a sealing edge with a width of 1.25 mm, when it is at the off position.

The Reason for Saving Power

1 There is a high utilization factor of the cylindrical round area.

For the traditional type of ring and disk valve mounted on the piston cover, the utilization factor of the cylindrical round area is up to about 50% at most, except the assemble valve. The new type of sliding valve, however, can reached above 90%. For exemple, the diameter of the cylinder is 153 mm, we may put the circle of the ring-type valve 10.2 ~ 11.5 cm, if valve lift h=0.25 cm, the valve gap section area A=16 ~ 18 cm^2. The sum of the length of all the slots in the sliding valve is 85 ~ 88 cm, and the width of the slot is 4 mm. So, taken together, the section area A is 34 ~ 35 cm^2, which is one time more than that of the ring valve. Besides, there are no slots in the sliding valve beyond the cylinder wall with the diameter D. However, in the ring valve there is about 1/3 ~ 1/2 of the circular slots out of the cylinder wall. We can see that the area of the former is not only one time larger than that of the latter, the gas flow is also straight and direct. Whereas the gas flow in the ring valve is circulating, and about 1/3 ~ 1/2 of gas is flowing eccentrically. So the curve of intake gas pressure is close to the nominal curve of intake pressure.

2 The elimination of the resistance loss caused by the unmatched gas thrust and spring in the ring and disk valves

Even if the two force of the valve is well matched, there is still an effect on the gas going into the cylinder, owing to the recoil during switching on and longer period taken during switching off. The new type valve is a kind of mechanical driver by a cam system. Take the intake valve as an example, the piston is running in the expansion process, when the pressure in cylinder decreases just as much as the pressure in the intake pipe (the nominal pressure of intake gas), the pressure difference between the inside and outside valve 9 is zero, at the same time the valve is pushed to the halfway position and then to the full switching on position immediately. So the dotted line under the nominal pressure curve in the indicator (Fig.2) is very close to it, the shaded area between them is almost zero. The amount of lose caused by circulation and poor matching in the ring valve is 15~5% of indicated power, which cannot be compared with that of the sliding valve.

3 The resistance loss of cam transmission system

The transmission loss similar to the Boche oil pump in this device is very small, because the cam is fixed in a well-processed plain bearing. The resistance caused by the cam going from the base circle to the profile is very small, because the weight of the valve is only 25 N, and the sliding valve is in an isobaric field when it is switched on. The cam merely needs to overcome the friction caused by gravity as the valve parallelly shifts. Even the friction factor f=0.1 is taken, the friction will be 25 X 0.1=2.5 N, that is, the real force to be overcome by the cam is the pressure force P of the spring after the valve shifts. The indexes of the spring in this device are: d=1.5 mm, winding diameter D=15 mm, number of effective circles n=8, so the rigidity factor is 1.84 N/mm, the precompression is 10 mm, the distance from the profile of the cam to the base circle is 5.25 mm, the max. spring force of switching on is 28N=2.86Kg. The sum is 2.86+0.25=3.11 Kg.

The loss of the chain wheel can be neglected because of the chain transfer having a high effecient 0.98.

To sum up, the new-type sliding valve could save power by 15% comparing with the traditional valve.

Why the Amount of Intake Gas is Increased

As mentioned above, the flow area is larger, all the slots are in right blowing position, the whole process of the valve switching on is static, and the slots of the valve seat are in accordance with the slots of the valve, which makes the gas go into the cylinder vertically and directly, in addition, the clearance of the gap is small, therefore the new-type valve has an increasing amount of intake gas by 30% comparing with the first generation, which depends on the pressure difference to switch on and has a bending flow, even the third generation of straight-flow valve. It is sure to increase the intake gas by 20~25%.

Draw Backs to be Overcome

1. This type of valve is unadaptable to a variable working conditions, for example, when starting up with no load, there is no gas pressure in the cylinder and the expansion angle is very small, however, the calculated expansion angle for this devise is 32°45' (the intake angle is 147°15'), so the vacuum in the cylinder takes place transiently. If the profile of the cam is made in the slant transient shape along the oxis, the intake valve can be opened at expansion angle = 20° (intake angle is 160°). As the displacement of piston is very small within 20° and larger vacuum can not take place, so the profile of the cam need not be considered. By operating a handle, the cam shaft can be shifted along the oxis; and according to the pressure created in the cylinder, the cam shaft can be restored to its original state by gradually controlling the handle.

2. There should be a one-way valve between the exhaust pipe and the gas storage tank.

3. It is not suitable for those compressors which stop frequently.

CONCLUSION

With the help of ACD, new-type valve will be used widely; owing to its advantages mentioned above, it is most suitable to be applied to a single-stage or double-stage air compressor which runs steadily.

APPENDIX

	Pressure, x 10^5 Pa	Open angle	Close angle
Suction Valve	p_s=1.01	32°45'	180°
Discharge Valve	p_d=3.0	283°30'	360°

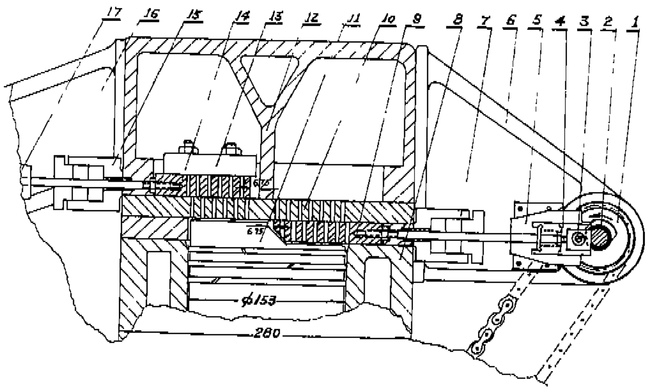

Fig. 1 Section arrangement of sliding valve

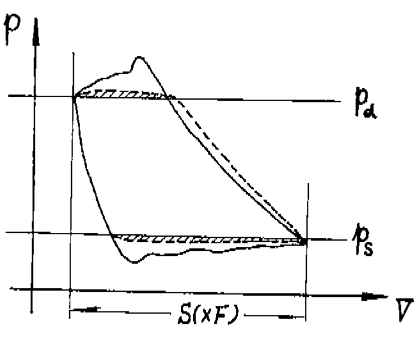

Fig.2 Indicator curve dotted Line sliding valve